# Effect of Neutron Irradiation on the Microstructure of the ODS 14YWT Ferritic Alloy

David T. Hoelzer[1], Maria A. Auger[2], Michael P. Moody[3], Philip D. Edmondson[1], Kevin G. Field[1]

[1]Oak Ridge National Laboratory, Oak Ridge, TN, USA
[2]Physics Department, Universidad Carlos III de Madrid, Madrid, Spain
[3]Department of Materials, University of Oxford, Oxford, UK.

The oxide dispersion strengthened (ODS) 14YWT ferritic alloy was developed for advanced nuclear energy reactor applications requiring high performance and tolerance to extreme irradiation environments. The microstructure of 14YWT (Fe-14Cr-3W-0.4Ti-0.3$Y_2O_3$; wt.%) consists of a high concentration of Ti-, Y- and O-enriched nano-size oxide particles and ultra-fine grain structure that contribute to the attractive high-temperature mechanical properties, such as strength, creep resistance and failure characteristics. Considerable knowledge of the effects of irradiation on the microstructure of 14YWT has been obtained from numerous ion irradiation studies involving doses of greater than 500 dpa over temperatures ranging from -75ºC to 600ºC. Recent results are beginning to emerge from studies investigating the effects of neutron irradiation on the microstructure and mechanical properties of 14YWT that will more clearly define the radiation tolerance of this alloy. The microstructural results that will be presented cover several heats of 14YWT that were neutron irradiated in rabbit capsules at the high flux isotope reactor (HFIR) at Oak Ridge National Laboratory up to doses of ~20 dpa at temperatures between ~400ºC and ~800ºC and at the BOR-60 reactor in Russia to a dose of ~16.6 dpa and two different temperatures of ~386ºC and 412ºC. The characterization of the irradiated microstructures of the 14YWT heats was conducted using transmission electron microscopy (TEM), scanning TEM (STEM), energy filtered TEM (EFTEM) and atom probe tomography (APT). The results showed nano-size oxide particles present in grains and on grain boundaries and no evidence of dislocation loops or cavities for all neutron irradiation conditions. At all neutron irradiation temperatures, Cr segregation to grain boundaries was observed. However, Cr-rich alpha prime ($\alpha$') particles formed during neutron irradiation at 386ºC and 412º C of the BOR-60 irradiations but were not observed at the higher irradiation temperatures of the HFIR rabbit irradiations. This presentation will cover the current understanding of the influence of neutron irradiation on the microstructure and will relate the results to limited mechanical properties that have been obtained from neutron irradiation of 14YWT.